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INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM--SOVIET-BLOC ACTIVITIES

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I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Announcement on Far-Side Photography by Third Soviet Cosmic Rocket

The following TASS communication on the photographing of the Moon's far side appeared in several Soviet newspapers on 27 October.

In accordance with the designated program of scientific investigations, on 7 October at 0630 hours Moscow time, the apparatus aboard the automatic interplanetary station designed for taking pictures of the side of the Moon invisible from the Earth and for the subsequent transmission of this information to Earth was switched on.

The automatic interplanetary station was equipped with an orientation system and phototelevision apparatus with special equipment for automatically processing the photographic film.

The time of photographing was selected so that the station, in its orbit, was situated between the Moon and the Sun, which illuminated about 70 percent of the Moon's invisible side. At this time, the station was at a distance of 60,000 to 70,000 kilometers from the surface of the Moon.

The orientation system, switched on by special command signal, turned the station in such a manner that the objective of the photographic apparatus was directed toward the reverse side of the Moon and gave the signal for switching on the photographic apparatus.

Photographing of the Moon lasted about 40 minutes, thus a considerable quantity of photographs of the Moon were obtained in two different scales.

Processing of the photographic film (development and fixing) was carried out automatically on board the interplanetary station.

Transmission of the pictures of the Moon to Earth was done with the aid of a special radio technical system. This system simultaneously ensured the transmission of scientific data, the determination of the elements of the orbit, and also the transmission from the Earth to the station of the command controlling its operation. The television apparatus ensured the transmission of half-tone pictures of high resolution.

The first pictures of the invisible part of the Moon, obtained as a result of preliminary processing, will be published in newspapers of 27 October, with the necessary descriptions, and then in scientific publications.

The Academy of Sciences USSR has created a commission for naming the craters, ridges, and other features of the invisible side of the Moon.

On board the automatic interplanetary station, is apparatus intended for conducting scientific investigations in interplanetary space. The results of the scientific investigations obtained were recorded on tape by ground stations and are now being processed.

The operation of the automatic interplanetary station on its first revolution showed that the flight of a cosmic object according to a predetermined orbit was successfully ensured; the problem of orienting an object in space was solved; radiotelemechanical communication and the transmission of television images in space was accomplished; and a picture of the side of the Moon inaccessable to investigations up to now and a number of other scientific results were obtained. ("On the Motion of the Third Soviet-Cosmic Rocket;" Moscow, Pravda, 27 Oct 59, p 1)

Lifetime of 1 1/2 Years Predicted for Third Soviet Cosmic Rocket

Refinement of the orbital parameters of the automatic interplanetary station shows that it will have a lifetime, determined from the moment of its launching, of 1 1/2 years, states a TASS communication. During this time, it will complete 11 to 12 revolutions of the Earth. The report further states that at the end of this time, the interplanetary station will enter the dense layers of the Earth's atmosphere and burn up. ("On the Motion of the Third Soviet Cosmic Rocket;" Moscow, Pravda, 27 Oct 59, p 1)

Bulletins on Soviet Cosmic Rocket III

Bulletins on the progress of the third Soviet cosmic rocket continue to appear from time to time in the daily Soviet press. These reports give information only on the location of the station in relation to a point over the surface of the Earth, its distance from the Earth, and the velocity of the station.

On 21 October at 2000 hours Moscow time, the station was over a point on the surface of the Earth with coordinates of 37 W 21 S, 342,000 kilometers from the Earth, and traveling at a speed of 0.89 kilometers per second.

According to the 22 October bulletin, the station will be at its maximum distance from Earth, 483,000 kilometers, on 26 October when the next transmission of information will be received at 1500-1600 hours Moscow time. ("On the Motion of the Third Soviet Cosmic Rocket;" Moscow, Pravda, 22 Oct 59, p 1)

At 2000 hours Moscow time on 27 October, the interplanetary station will be over a point on the surface of the Earth with coordinates of 38 6 W and 6 30 N and at a distance of 484,000 kilometers, ("On the Motion of the Third Soviet Cosmic Rocket;" Moscow, Pravda, 27 Oct 59, p 1)

Soviet Scientist Discusses Moon's Far Side

A. Markov, Doctor of Physicomathematical Sciences and leader of a group studying the planet Moon at Pulkovo Observatory, makes the following comments on the recent pictures of the Moon's far-side taken by the third Soviet cosmic rocket.

The pictures of the invisible side of the Moon were taken at a distance of 60,000-70,000 kilometers, when the automatic interplanetary station was between the Sun and the Moon. The carefully designed system and apparatus aboard the station ensured its proper aspect at this moment. Photographing lasted about 40 minutes.

The pictures published on 27 October showed a great difference in the actual surface of the unseen side of the Moon with that imagined by many authors of hypothetical maps, in particular the astronomers Franz and Wilkins. A survey of the first Soviet pictures of the Moon's unseen side showed that the surface is predominantly mountainous and, contrary to expectations, only two "seas" are visible; the seas Moskva and Mechta, so named by the Commission of the Academy of Sciences USSR for Naming Formations on the Reverse Side of the Moon. Thus, only 10 percent of the area of the invisible side of the Moon appears to be covered by "seas," while on the area visible from the Earth, "seas" cover 30-35 percent of its surface.

The reasons for this and sounder conclusions concerning the history of lunar orogenesis will be made jointly later on by astronomers and geologists. In addition, there will naturally be taken into consideration the fact that the action of the tidal forces, having their origin in the Earth's attraction, is more strongly expressed on the visible side of the Moon. It is further necessary to consider, that during lunar eclipses, which take place up to twice a year, a very sharp change in temperature occurs, up to 250 degrees in half an hour. It is possible that these two reasons are sufficient for lava to pour out through cracks in the crustal surface of the Moon caused by cracking of the soil under the effect of intense temperature changes. Because of this, larger "seas" are formed on the visible side of the Moon than on its invisible side. Changes in temperature on the invisible side occur less sharply because of the absence of lunar eclipes.

Some astronomers, considering that orogenesis on the surface of the Moon depends on meteorites falling on it, also note that in regard to the frequency of meteorites falling on the lunar surface, different conditions exist for each side. The detailed study of Soviet pictures of the far-side of the Moon must give new data concerning our satellite [the Moon] and the evolution of its surface. ("The Nature of the Invisible Half of the Moon," by A. Markov, Doctor of Physicomathematical Sciences; Moscow, Pravda, 28 Oct 59, p 8)

Soviet Test Pilot Seen as First Man in Space

"We are convinced that the first man to fly in space will be a Soviet man. Our test pilots are exerting every effort to see to it that the first man in space will be a Soviet test pilot." So concludes Engr Col G. Sedov, Hero of the Soviet Union and distinguished test pilot, in an article appearing in Sovetskaya Aviatsiya, answering a reader's question on what qualities the man who will fly in space must possess.

Sedov believes that a test pilot is peculiarly suited for such a task because of the nature of his work. In addition to bravery, a deep engineering knowledge is necessary, since without it, laboratory work during the flight will be of little use. A knowledge of the laws of flight is also necessary, as without it, proper training would be impossible. ("On the First Cosmonaut," by Engr Col G. Sedov: Moscow, Sovetskaya Aviatsiya, 18 Oct 59, p 3)

Complete Press Report on Third Soviet Cosmic Rocket

A complete report, as it appeared in a Moscow paper on the third Soviet cosmic rocket is given below.

The successful launching of the third cosmic rocket was carried out in the Soviet Union 4 October 1959. It was launched with the aim of solving a number of problems in the study of outer space. The most important goal was to obtain a photograph of the surface of the moon. It was of special scientific interest to obtain a photograph of that portion of the Moon's surface which, as a result of peculiarities of its movement, is altogether inaccessible to observation from the earth, as well as of a portion of the surface visible from the earth at such an acute angle that it cannot be studied reliably.

An automatic interplanetary station was created for the detailed study of cosmic space and for obtaining a photograph of the Moon. With the help of a multistage rocket, it was placed in an orbit which bends around the Moon. Precisely in accord with calculations, the automatic interplanetary station passed at a distance of several thousand kilometers from the Moon and, as a result of its attraction, changed the direction of its flight. This made it possible to obtain a flight trajectory suitable for photographing the side of the Moon which is invisible from the Earth and for transmitting to Earth the scientific information obtained. The launching of the third cosmic rocket and the placing of the automatic interplanetary station in the predetermined orbit demanded the solution of a number of new and highly complex scientific and technical problems.

The multistage rocket used for placing the station in orbit possessed advanced design and also powerful motors burning a high-calorie fuel. The rocket's guidance system during the powered stage of its flight assured the desired degree of accuracy in its motion. The scientific observations carried out with the aid of the automatic interplanetary station have made possible the acquisition of a considerable quantity of materials which are now being processed.

Of tremendous scientific interest are the photographs obtained of that side of the Moon which is invisible from the Earth. For the first time in history, it has become possible to observe that portion of the Moon's surface which has never been observed from the Earth. The launching of the automatic interplanetary station testified to the high level of development of our science and technology.

Layout of the Automatic Interplanetary Station

The automatic interplanetary station is a space flight vehicle equipped with a complex range of radiotechnical, photographic, television, and scientific instruments; with a special system of orientation; with devices for the programmed control of the instruments on board; with a system of automatic regulation of the temperature inside the station; and with sources of power supply.

A special radiotechnical system ensures the measurement of the parameters of the station's orbit, the transmission to earth of television and scientific telemetric information, and the transmission from the Earth of signals controlling the work of the instruments on board the interplanetary station. The orientation system ensured the aspect of the interplanetary station in cosmic space in relation to the Sun and the Moon necessary for photographing the invisible side of the Moon.

All control of the work of the instruments on board the station is carried out from ground points by radio, as well as by self-contained programing devices on board. Such a combined system makes possible the most effective way of controlling scientific experiments and of obtaining information from any sectors of the orbit within radio range of the observation points on the Earth.

A automatic thermal regulation system operates uninterruptedly for the purpose of maintaining a predetermined temperature within the station. It ensures the dissipation of heat emitted by the instruments, via a special radiating surface, into outer space. To regulate the loss of heat, baffles have been fixed on the outside of the body, which open up the radiating surface when the temperature inside the station rises to plus 25 degrees centigrade.

The power supply system contains autonomous units of chemical sources of current which supply instruments operating for brief periods of time, as well as a centralized unit of auxiliary chemical batteries. The expenditure of power by the auxiliary battery is compensated for by solar sources of current. Current is supplied to the instruments on board via transformer and stabilizer installations.

The set of scientific instruments installed on board the automatic interplanetary station ensures the further development of the study of cosmic and circumlunar space begun by the first two Soviet cosmic rockets.

The automatic interplanetary station is a thin-walled, hermetically sealed vessel, shaped like a cylinder, with spherical ends. The maximum diameter of the station is 1,200 millimeters; its length is 1,300 millimeters, excluding the antennas.

The instruments and the chemical power sources are located inside the body, on a frame. A number of scientific instruments, the antennas, and the sections of the solar battery are located outside. The upper part contains a port with a shutter which opens automatically before the photographing begins. The upper and the lower ends have small ports for the solar transducers of the orientation system. The motors of the orientation system are fixed at the lower ends.

A scheme according to which the cameras were brought to bear on the Moon by the rotation of the entire interplanetary station was deemed to be most expedient for photographing the Moon. The orientation system on board the station turned the automatic interplanetary station and held it steady in the direction required.

The orientation system was switched on after the station had approached the Moon, at the moment when the station was in a predetermined position in relation to the Moon and the Sun, which ensured the necessary conditions for orientation and photography. According to estimates, the distance from the moon at that time was 60,000-70,000 kilometers.

At the beginning of the operation, the orientation system, which includes optical and gyroscopic transducers, electronic computers, and controlling motors, first of all, stopped the free rotation of the automatic interplanetary station around its center of gravity, a rotation which began at the moment of separation from the last stage of the carrier rocket.

The automatic interplanetary station is being illuminated by three bright celestial bodies -- the Sun, the Moon, and the Earth. The trajectory of its flight was selected so that at the moment of taking the photographs the station would be approximately on a straight line connecting the Sun and the Moon. Then, the Earth had to be away from the Sun-Moon line so that there could be no orientation toward the Earth instead of toward the Moon.

The indicated position of the interplanetary station in relation to the celestial bodies at the moment orientation began allowed the following method to be utilized:

The station's lower end was initially directed toward the Sun with the help of the Sun seekers; thereby, the optical axes of the cameras were aimed in the opposite direction -- toward the Moon. A special optical device, in whose field of view the Earth and the Sun could no longer appear, then switched off the orientation to the Sun and permitted precise orientation on the Moon. The signal showing the Moon's presence, which had been received from the optical instrument, permitted automatic photography. Throughout the period of photographing, the orientation system ensured that the automatic interplanetary station was constantly focused on the moon. After all of the pictures were exposed, the orientation system was switched off. At the moment the system was switched off, it imparted to the automatic interplanetary station an ordered rotation at a fixed angular velocity which was selected in such a way as to improve the temperature regime, while at the same time excluding the effect of the rotation on the function of the scientific instruments.

Flight of the Interplanetary Station

The orbit of the automatic interplanetary station is especially suited for the solution of the set of scientific problems established. To obtain the desired orbit, in addition to ensuring the necessary speed and direction of the station's flight at the burn-out moment of the rockets last stage, the gravitational pull of the moon also was utilized.

The trajectory of flight around the Moon had to satisfy a number of requirements. To ensure the correct functioning of the orientation system at the time of photographing the Moon, it was necessary, as has been said above, that the Moon, the station, and the Sun should lie approximately on a straight line at the initial moment of orientation. The distance between the station and the Moon during the period of photography was chosen in the range of 60,000-70,000 kilometers.

The character of the trajectory had to make possible the acquisition of the maximum quantity of information on the first curve around the Moon, especially at short distances from the surface of the Earth. With a view to meeting this requirement, it was necessary to ensure the best possible conditions of radio communication with the interplanetary station from points lying in the territory of the Soviet Union. For the purpose of scientific research, it was also highly desirable to obtain a trajectory that would ensure the flight of the interplanetary station in space for a sufficiently long period of time.

A flight around the Moon with return toward the earth can be carried out along various types of trajectories. To achieve such trajectories, the speed at the end of the powered flight must be a little less than the so-called second cosmic or parabolic velocity, which is equal, near the surface of the earth, to 11.2 kilometers per second.

If the trajectory of the flight is several tens of thousands of kilometers from the Moon, its influence is comparatively small, and the motion in relation to the Earth will take place along a trajectory approximating an ellipse, with one of the foci in the center of the Earth.

However, the trajectory of a distant flight around the Moon, circling it at a distance of several tens of thousands of kilometers, has a number of basic drawbacks. In flying at great distances from the Moon, the investigation of cosmic space in the direct vicinity of the Moon is impossible. When the rocket is launched from the Northern Hemisphere, the return toward the Earth takes place from the side of the Southern Hemisphere. This complicates observations and reception of scientific information by the stations situated in the Northern Hemisphere. The flight near the Earth on the return leg takes place outside the limits of visibility from the Northern Hemisphere, and, therefore, the reception of information near the Earth of the results of scientific observation becomes impossible. On its return toward the Earth, the rocket enters dense layers of the atmosphere and burns up, that is, the flight ends after the first loop.

These shortcomings can be avoided by making use, during the flight around the Moon, of another type of trajectory passing close to the Moon at a distance of several thousands of kilometers. The trajectory of the automatic interplanetary station passed at a distance of 7,900 kilometers from the center of the Moon and was calculated in such a manner that when the station was at its nearest point to the Moon, it was to the south of it. As a result of the Moon's attraction, the trajectory of the automatic station, in accordance with calculations, deviated to the north. This deviation was so great that the return toward the Earth took place from the Northern Hemisphere. In this way, after approaching the Moon, the maximum height of the station over the horizon increased daily for the observation stations situated in the Northern Hemisphere.

Correspondingly, the intervals at which direct contacts with the automatic station were possible increased. Sufficiently, close to the Earth, the automatic station could be observed in the Northern Hemisphere as a non-setting celestial body. The conditions for receiving information during the return toward the Earth and the conditions for conducting scientific studies during the return to the direct vicinity of the Earth were sufficiently favorable. During its return toward the Earth on the first circuit, the station did not enter the atmosphere and did not perish, but passed at a distance of 47,500 kilometers from the center of the Earth, moving along an elongated elliptical orbit of very great size.

The greatest distance of the station from the Earth was 480,000 kilometers. Thus, while passing near the Moon, it appears that it is possible to achieve trajectories in the movement of an automatic interplanetary station which are exceptionally interesting and advantageous from the viewpoint of scientific research and of receiving scientific information.

The flight of the interplanetary station near the Earth is taking place at such great distances from its surface that there is no drag due to resistance by the atmosphere. Therefore, had the movement taken place only under the influence of the earth's gravity, the automatic station would be like an Earth satellite with an unlimited period of existence. However, in reality, the time of the station's flight is limited. As a result of the perturbing influence of the Sun's gravity, the nearest distance of its orbit from the Earth, the height of its perigee, is gradually diminishing. Therefore, having made a certain number of revolutions, the station will enter the dense layers of the atmosphere and burn up. The amount of decrease in the height of the perigee in one circuit depends on the parameters of the orbit, particularly on the height of the apogee, i.e., on the greatest distance of the orbit from the Earth. It raises sharply as the height of the apogee increases. Therefore, in choosing the trajectory of the interplanetary station, it was necessary to achieve the smallest possible height of the apogee, which would only slightly exceed the distance from the Earth to the Moon. It is also essential to achieve the greatest possible height of the perigee in the first circuit. The total number of circuits of the automatic station around the Earth and the period of its existence depend on the degree to which the above-mentioned requirements are fulfilled.

The influence of the Moon does not limit itself to the effect created during the period of the first close approach. The perturbation of the station's orbit by the Moon's gravity is not of such a regular nature as the perturbation created by the sun and depends greatly on the period the station circles the earth. The Moon's influence can be considerable only when the station approaches sufficiently close to the Moon on any one of the subsequent circuits. In this case, the station will be nearest to the Moon roughly at the same point of the orbit as the first time. In case of a repeated close approach, the nature of the station's movement could change substantially. If the interplanetary station passes near the Moon from the south, that is, if the second approach is of the same type as the first one, the number of revolutions and the period during which the station preserves the main features of its trajectory, approaching the Earth from the Northern Hemisphere, will increase sharply. If the repeated passages take place from the north, the height of the orbit's perigee will be reduced, and in the case of sufficiently strong perturbation: a collision with the Earth could take place on the next return trip toward it.

On those loops of the orbit where the station does not come close to the Moon, the latter, nevertheless has some influence on the station's movement. Although the force of the Moon's attraction is, in this case, very small, since it acts on a large number of loops of the trajectory, the Moon's gravity has noticeable influence on the movement of the automatic station, causing a reduction in the height of the perigee and the period of the station's existence in the orbit.

The picture of the movement of the automatic interplanetary station under the influence of the simultaneous forces of gravity of the Earth, Moon, and Sun is very complicated. The nature of the first passage close to the Moon is decisive for the future motion of the interplanetary station. Since no corrections in the station's movements are made during its flight and its whole flight is determined in the final account by the parameters of the movement at the end of the powered flight (by the magnitude and the direction of speed), it is clear that the realization of the above-described trajectory by the space station is possible only with an exceptionally perfected system of control over the carrier rocket during the powered portion of the flight.

Calculations show that with a deviation of 1,000 kilometers of the point of intersection of the station with the picture plane (kartinnaya ploskost), the minimum distance between the Earth and the station during its return will change by 5,000-10,000 kilometers, and the time of the nearest approach to the Earth, by 10 to 14 hours. The plane in this case is the plane passing through the center of the Moon perpendicular to the Earth-Moon line.

So that the maximum fluctuation in the minimum distance between the Earth and the station will not exceed 20,000 kilometers, it is essential to launch the rocket with sufficient precision to insure a deviation in the point of intersection with the picture plane of not more than 3,000 kilometers.

At first glance, this demand placed on the rocket's guidance system seems to be easier to meet than the conditions required for hitting the Moon, since in order to hit the Moon, the limited deviation of the rocket from the point of sighting or the calculated point of intersection with the picture plane must not exceed the Moon's radius, that is, must be roughly two times smaller than 3,000 kilometers. However, when the station moves along the trajectory encircling the Moon, the errors in putting the rocket into orbit have a much greater influence on the deviation of the point of crossing the picture plane than in the impact trajectory of the second cosmic rocket which hit the Moon. Indeed, as already reported, the variation in the speed of the rocket in free flight of one meter per second from the version of the rocket which hit the Moon leads to a deviation of the intersection point with the picture plane by 250 kilometers, and in the version circling the moon, this deviation equals 750 kilometers, or three times more. Only from a comparison of these figures can it be seen that the realization of a fixed version of an encircling trajectory places more rigid demands on the accuracy of the guidance system of the rocket than in the version which hit the Moon.

As already mentioned, during the passage of the interplanetary station close to the Moon, the station's trajectory is affected by strong disturbances which compel it to change the original direction of its movement, causing a return toward the Earth from the side of the Northern Hemisphere. This perturbing action of the Moon substantially increases the influence of the variations of parameters of the movements at the end of the powered flight from their calculated values on the station's movement during its return toward the earth after circling the Moon. Therefore, even small errors in the determination of these parameters lead to very substantial errors in the calculation of the characteristics of the station's movement during its return toward the Earth.

At the same time, in order to establish reliable radio communication by the interplanetary station with the ground-based observation stations, it is necessary to know, with sufficient accuracy, the change in time of the parameters of the movement of the station. This is essential in order to conduct calculations with the required accuracy of the target designation by the tracking points and to determine the times for switching on the transmitting apparatus aboard the station.

This circumstance requires a systematic measurement of the trajectory of the interplanetary station, the processing of data, and the improving of the accuracy of determining the parameters of the movement of the station both during the approach to the moon and after having encircled it. The influence of the Sun and the Moon on the evolution of the orbit of the interplanetary station during its further flight also requires constant measurement and improvement in the determination of the characteristics of the station's movement.

The above-described conditions place serious demands on the work of automatic measuring installations which measure the parameters of the interplanetary station's trajectory: calculate the prognosis of its movement, its target designation points for measuring, and observation stations; and calculate the time of switching on the transmitting devices on board the station during its flight around the Earth.

These installations include radiotechnical stations measuring the distance, angular parameters, and the radial velocity of the movement of an object; stations receiving telemetered information; and automatic communication lines of the tracking points with the coordinating computing center, which, on its part, is linked with ground stations which order the switching on of the transmitting equipment on board the station.

The command radio channel makes it possible to switch on radio-technical devices on board the station at certain intervals of time corresponding with the best conditions for radio communication from the station's transmitting equipment to the ground points situated in the Soviet Union.

The selection of the duration and time of transmissions is dictated by the necessity of allowing the requisite information to accumulate, a move which is essential for improving the accuracy of determining the characteristics and the prognosis of the movement of the interplanetary station, as well as by the necessity of preserving the power reserves on board the station.

Preliminary processing of the results of trajectory measurements shows that the automatic interplanetary station will continue in orbit until April 1960 and complete 11 or 12 revolutions around the Earth.

Photographing and Transmitting the Image

In designing the equipment for photographing and transmitting the image of the invisible part of the Moon from the automatic interplanetary station, the problem of developing a phototelevision system producing a halftone picture of good quality and transmitting it over hundreds of thousands of kilometers was successfully solved. A large number of complex scientific and technical problems were involved.

During the photographing, the orientation system ensured a position of the station in which the lunar disk would be in the field of view of the objective. The photographic and television equipment was designed to ensure proper functioning in the difficult conditions of cosmic flight. Photographic components were protected against the harmful effects of cosmic radiation, and normal functioning of the photographic and processing equipment under conditions of weightfulness was ensured.

The transmission of the image over great distances with a transmitter of extremely low power made necessary a transmission velocity which was tens of thousands of times slower than conventional television programs.

In the first photograph of the reverse side of the Moon, it seemed practical to obtain a picture of the largest possible part of its unknown surface. This led to the necessity of making a photograph of the fully illuminated disc, the contrast of which is always considerably lower than under oblique illumination producing shadows of the relief. To achieve the best possible result in transmitting the low-contrast picture, automatic brightness control was used in conjunction with the tube.

The principles of self-regulating circuits were used for the reliable operation of the apparatus under variable conditions. The coordination and control of all links, including electronic circuits and optical, mechanical, and photochemical devices, was carried out by a special automation and programing system.

The phototelevision equipment in the interplanetary station contains the following main instruments: a camera with two objectives, with focal lengths of 200 and 500 millimeters, used for the simultaneous filming on two different scales; the 200-millimeter objective gave a disc image which fitted entirely onto a frame. Large-scale images given by the 500-millimeter lens exceeded the size of the frame and gave a more detailed picture of parts of the lunar disc.

The filming was carried out with automatic variation of the exposure in order to get negatives with the best density and lasted for about 40 minutes, during which the far-side of the Moon was photographed repeatedly.

Photographing began at a command signal after the objectives had been trained on the Moon. The whole subsequent process of photographing and film processing was done automatically through a preset program.

The shots were taken on a special 35-millimeter film able to sustain processing at high temperature. To prevent fogging of the film due to cosmic radiation, a special shield was provided, chosen on the basis of research carried out with the help of the Soviet artificial satellites and cosmic rockets.

After the photographs were taken, the film entered a small automatic processing device, where it was developed and fixed. In the processing, a special method was used ensuring that the parameters of the negative were not greatly affected by the temperature. Necessary measures were taken to prevent the disturbance of the processing by conditions of weightlessness. After the film was processed, it was dried, which ensured lasting preservation. After processing, the film entered a special chamber where it was prepared for the transmission of the image.

Tests marks were put onto the film earlier, part of which were developed on Earth, with the others being developed on board the station in the process of the development of the film shots of the other side of the Moon. These marks were transmitted to the Earth and made it possible to keep control of the process of photography, development of the film, and transmission of the images.

To transform the images on the negative into electric signals, a small scanning tube, capable of a high resolving capacity, and a highly stable photoelectronic multiplier were used. The transmission of the images to earth was done in a way similar to that by which films are transmitted by television centers. To deflect the rays of the electronic tube, economical low-frequency scanning devices were used. Amplification and shaping of the signals of the image were achieved by a specially-devised, narrow-band, stabilized amplifier containing a device for automatic compensation of the influences of the variations of density of the negative on the output signal.

All of the circuits were basically made up of transistors. Transmission of the signals was designed so as to be accomplished by two methods: slow transmission over great distances and rapid transmissions at shorter distances during the approach toward the Earth.

The television system enabled the number of lines into which the image was divided to be altered according to the transmission conditions. The maximum number of lines reached 1,000 per frame. To synchronize the transmitting and receiving scanning devices, a method was used which assured a high degree of stability against interference and reliability in the operation of the apparatus.

The images of the Moon were transmitted from the automatic interplanetary station on the radio communication link, which, at the same time, was used for the measurement of the parameters of the movement of the station itself, namely, the distance, velocity, and the angular coordinates, as well as for the transmission of the results of scientific experiments with the help of telemetric instruments.

The switching on and off of the various instruments on board the station and the changing of their operations were accomplished by the transmission of special commands from the Earth to the station on the same radio channel.

The transmission of the images of the Moon and all other functionings along the communication link from the station were carried out by means of the continuous emission of radio waves, as distinguished from the pulse radiations used previously in certain cases. Such a combination of functions in a single radio communication link by means of constant radiation has been achieved for the first time and has enabled a reliable radio contact to be maintained right up to the maximum distances with a minimum expenditure of energy on board.

The radio communication link with the station consisted of two sections: earth-to-station and station-to-earth. It included the command devices, powerful radio transmitters, highly sensitive receiving and recording devices, and antenna systems located at radio contact points on the Earth, as well as transmitting, receiving, and antenna devices in the interplanetary station.

In addition to this, station command and programming radiotechnical devices were on board. The entire system of instruments of the radio communication link, both on board and on Earth, was duplicated to increase reliability of contact. In the event of the breakdown of one of the radiotechnical instruments on board or the exhaustion of its operating resources, it can be replaced by a reserve instrument by an appropriate command from the control point on Earth.

The transmission of the images of the Moon was done by commands from the Earth, including the switching of the power for the television instruments on board, the rolling of the film, and the tapping-in of television apparatus to the transmitters on board. As a result, the law of the change in the brightness on the lines which form the image was transmitted back to earth.

The total volume of scientific information transmitted along the radio contact channel, including shots of the images of the moon, greatly surpassed the volume of information which was transmitted from the first and second Soviet cosmic rockets.

To ensure the reliability of the transmission of this information in the presence of a considerable noise level due to cosmic radiation, an especially effective method of radio communication was used, a method that ensured the minimum expenditure of energy from power sources on board. To conserve electrical energy, the power of radio transmitters on board was fixed at several watts. Semiconductors and other modern parts and materials were used in the receiving and transmitting instruments on board. Special attention was paid to attaining minimum size and weight of instruments.

The difficulties entailed in ensuring reliable radio contact with the automatic interplanetary station may be judged if one considers what portion of power transmitted by the radio on board reaches ground-based equipment. So that contact with the station should not cease during its rotation, the antenna of the station radiates radio signals uniformly in all directions so that the power of the radiations per unit of surface will be equal for all points on an imaginary sphere in the center of which the station is located.

The receiving antenna on Earth receives a part of the power of radiation determined by the ratio of the effective area of the receiving antenna to the surface of the sphere having a radius equal to the distance from the station of the receiving point. Therefore, large antenna are used to receive signals from the station. However, at the station's maximum distance from the Earth, the part of the power of the radiation received from the transmitter on board is 100 million times less than the average power received by an ordinary television receiver.

To receive such weak signals, extremely sensitive receiving instruments with a low level of output noises are needed. The noise output at the receiving device on earth is composed of noises of cosmic radiation, received by the antenna, and the receiver's own noises, which, through a number of special measures, have been reduced to a minimum. The reduction of the volume of noise is usually connected with a reduction of the speed of the transmission of the information.

In connection with what has been said, such methods of processing and transmitting signals on board the station and at receiving points on the Earth have been used in the radio communication link which reduce the noise level to the maximum degree and retain a permissible speed of transmission.

The economical use of the sources of power on board the station, the existence of the radio communication link with continuous radiation and combined functions, the use on earth of special receiving antennas, highly sensitive receiving devices, the use of special methods of processing and transmitting signals -- all of these factors enabled reliable radio contact to be maintained with the automatic interplanetary station, the perfect functioning of the radio command channel, and the planned photographing of the image of the Moon and the telemetering of scientific information.

The signals of the television images received by the receiving points on Earth were registered by various pieces of equipment which ensured a necessary amount of reserve and made it possible to control the transmission process and exclude specific distortions caused by properties of the radio communication link and the recording devices.

The signals of the image of the Moon were fixed with special devices to register the television images on photographic film, with magnetic tape recorders possessing a high degree of stability in tape speed, with skiatrons (cathode ray tubes with screen image preservation), and with recording devices using electrochemical paper. The data obtained from all the forms of recording are used in the study of the far side of the moon.

With the aid of the television circuit on board the interplanetary automatic station, the image was transmitted over distances up to 470,000 kilometers. Thus, for the first time, it has been proven experimentally that half-tone pictures of great clarity can be transmitted in space over great distances without substantial distortion in the process of radio wave propagation.

Invisible Side of the Moon:

The period of the Moon's revolution around its axis is equal to the period of its revolution aroung the Earth. Consequently, the same side of the Moon is turned toward the Earth at all times. In the distant past, millions of years ago, the Moon revolved faster around its axis. In fact, one revolution took only several hours. The forces of tidal friction caused by the attraction of the Sun and the Earth slowed down the Moon and lengthened its period of rotation until it reached 27.32 days.

Up to now, maps could be compiled only for the visible section of the Moon, which has now been studied through telescopes for $3\frac{1}{2}$ centuries. These maps show ring mountains, mountain ranges, dark patches of lunar soil known as "seas," and other features. From the earth, we see not just half of the lunar surface, but slightly more -- 59 percent. Certain features of the Moon's surface are situated at the very edge of the visible disc and, therefore, could not be studied in any great detail because of considerable distortions in perspective.

The fact that it is possible to study somewhat more than half of the moon from the Earth is explained by the existence of the so-called librations of the Moon, i.e., a rocking of the Moon from the point of view of the observer on Earth. The photographing of the Moon from the interplanetary space station was carried out at the moment when the station was located on a line linking the Sun and the Moon, that is, when the moon appeared from the station to be an almost fully illuminated disc.

The photographs show that part of the Moon's surface which is invisible from the Earth, as well as a small area with features that are already known. The existence of this area on the photographs made it possible to tie in features on the Moon's surface which had never been observed previously to features already known and thus determine their selenographic coordinates.

Among the features photographed from the interplanetary station and visible from the Earth are the Humboldt, Crises, Marginal, and Smyth seas, and part of the Southern Sea. These seas, situated at the very edge of the Moon still visible from the Earth, appear narrow and long to us because of distortion of perspective. Their real shape had remained undetermined until now. On the photographs taken from the interplanetary station, these seas lie far from the visible edge of the Moon, and their shapes are little distorted by the perspective. Thus, it has, for the first time, been possible to find out the true shape of a number of lunar formations.

From available photographs of the invisible portion of the Moon's surface, a predominance of mountainous areas is noticeable, whereas seas similar to these on the visible portion are very few. Crater seas lying in the southern region and near the equator stand out sharply. From among the seas lying near the edge of the visible portion in a strongly out of perspective fashion, the Humboldt, Marginal, Smyth, and Southern seas stand out clearly and almost distortion free on the photographs. The Southern sea has been shown to have a considerable portion situated on the far side of the Moon, and its contours are irregular and meandering in form. Smyth Sea has a more rounded shape when compared to the Southern Sea, and a mountainous area cuts deep into it from the south.

The Marginal Sea is somewhat elongated northwards and has a bulge on the side away from the Sea of Crises. Humboldt Sea has a peculiar pear-shaped form. The entire area adjoining the western edge of the far side of the moon, i.e., the MarginalSea, has a reflecting capacity lying between that of mountainous areas and that of the seas. From the viewpoint of reflecting capacity, it resembles the region of the moon lying between the Tycho and Petavius craters and the Sea of Nectar.

To the south-southeast of the Humboldt Sea, on the edge of the above-mentioned region, there is a mountain range over 2,000 kilometers long which crosses the equator and stretches into the Southern Hemisphere. Beyond the mountain range, there is a vast continent with a higher reflecting capacity.

In the area lying between 20 and 30 degrees north latitude and 140 and 160 degrees west longitude, there is a crater sea about 300 kilometers in diameter, which ends in a bay at its southern portion.

In the Southern Hemisphere, in an area with the coordinates minus 30 degrees latitude and plus 130 degrees longitude, there lies a large crater over 100 kilometers in diameter with a dark bottom and a bright central peak surrounded by a light-colored, wide embankment.

To the east of the mountain range already mentioned, in the areas of plus 30 degrees north latitude, lies a group of four medium-sized craters, the biggest of which is some 70 kilometers in diameter. Southwest of the group, in an area with coordinates of plus 10 degrees latitude and plus 110 degrees longitude, there is a single round crater.

In the Southern Hemisphere, at the Western edge, lie two areas of sharply reduced reflecting capacities. In addition, the photographs show individual areas with slightly higher or lower reflecting properties, as well as numerous small details. It will be possible to determine the nature of these details, their shape, and dimensions after a more detailed study of all the photographs.

The fact that it has, for the first time, become possible to televise pictures of the invisible portion of the Moon's surface opens up the widest prospects for the study of the planets of our solar system.

The flight of the third cosmic rocket has inaugurated a new page in the history of science. Penetrating into cosmic space, Soviet cosmic rockets will now send to the Earth, not only information about the physical characteristics of the interplanetary medium and the celestial bodies, but also photographs of celestial bodies past which they will be flying.

For the first time, pictures have been transmitted by television over a distance of hundreds of thousands of kilometers. The widest prospects are opened up to astronomy, which has been enabled to bring its instruments nearer to the celestial bodies. The first Soviet automatic interplanetary station arouses every Soviet man's feelings of pride in our great socialist motherland, in leading Soviet science and technology. It arouses the admiration of all progressive mankind. ("The Third Soviet Cosmic Rocket"; Moscow, Pravda, 27 Oct 59, pp 3-5)

Frenchman Predicts Soviet Shots to Mars and Venus

A 7 October 1959 Paris dispatch, signed by S. T., appeared in the Italian Communist daily L'Unita of 8 October, predicting Soviet rocket shots to Mars and Venus, respectively, on 26 September 1960 and 15 January 1961, with the latter date as the first favorable one for the Venus launching. The prediction was made by Engr Albert Ducrocq in his book entitled Victory Over Space, published in French by Julliard. Ducrocq has an astounding record of prediction, having told his publisher to hold up the book until the first week of October because something sensational was in preparation by the Soviets. This turned out to be the third Soviet cosmic rocket. ("A Frenchman Predicts all Phases of USSR Space Conquest"; Rome, L'Unita, 8 Oct 59)

II. UPPER ATMOSPHERE

Largest Optical Telescope in USSR Nears Completion

Work on the largest Soviet telescope will soon be completed. At present this 120-ton structure stands in a seven-story building of a Leningrad opticomechanical plant.

The work of adjusting and balancing the various parts is now going on, supervised by B. K. Ioannisani, the telescope's chief designer. Adjustment of the complex turning mechanism is being done by L. A. Selivanov, F. P. Kamus, V. N. Klement'yev, and V. V. Zubin, mechanics. Tests are also being run on the lubricating system, which will ensure smooth operation of the optical tube, which weighs 70 tons. The last unfinished work is the electrical system. Work on the electrical drive units which will turn the telescope on several axes is the responsibility of G. M. Bruk, and T. N. Rudnev, engineers; V. I. Kopeyko and L. F. Tarasov, technologists; and N. P. Gorev, electrician.

A statement by Prof V. B. Nikonov, Doctor of Physicomathematical Sciences, chairman of the commission for building this telescope, gave the following information.

This new reflector telescope is one of the largest in the world. The diameter of its mirror is 2,600 millimeters. It is designated for the Crimean Astrophysical Observatory of the Academy of Sciences USSR. The lastest advances in engineering were incorporated into the design of the telescope. Sighting on celestial objects, their observation, and also exposure, focussing, and correction for refraction and other operations are automatized. The telescope has several optical systems. Focal length of the instrument can be changed according to the problem involved. There is also special-purpose apparatus such various spectrographs and photographic plate holders. The original design and tracking device ensure precise traveling observations.

With this unique optical instrument, Soviet scientists will be able to study nonstationary stars, the structure of the Moon, the planets of the solar system, and the distant galaxies, and they will track artificial earth satellites and cosmic rockets. ("One of the Largest in the World"; Moscow, Sovetskaya Aviatsiya, 25 Oct 59, p 4)

A photograph of the telescope, as it stands in the above-mentioned plant, appeared in the 22 October issue of Pravda. The caption gave no additional information on the telescope, and the picture itself revealed only the barest details of the open tube and fork mounting (Moscow, Pravda, 22 Oct 59, p 2)

Conference on Noctilucent Clouds

The All Union Conference of Geophysicists and Astronomers on the Study of Noctilucent Clouds is being held in Riga.

The origin of these clouds has not been definitely established up to now. They appear during certain months in fixed latitudes at an altitude of about 80 kilometers.

The following statement was made by Prof I. Khvostikov, chief of the Geophysical Laboratory of the Central Aerological Observatory.

"The priority of Soviet studies on noctilucent clouds is generally accepted. In our country, a classification of these clouds was developed which is used also by foreign specialists. The spectra of noctilucent clouds are studied by Soviet scientists. It is interesting to note that they are extremely similar to the spectra of the blue haze observed in Mars' atmosphere. The proposition suggests itself that in both cases we are dealing with particles of cosmic mists. According to another theory, noctilucent clouds, and, consequently, also the haze mentioned, are of water origin. The problem, we see, is important for a clarification of the question concerning the possibility of the existence of life on Mars." ("Noctilucent Clouds"; Moscow, Pravda, 25 Oct 59, p 6)

First Bulgarian Cosmic Ray Laboratory Completed

The building of the first cosmic ray laboratory in Bulgaria, in the Rilskiy /Rila Digh?/ Mountains, has been completed, according to a TASS report from Sofia. The study of cosmic rays being conducted in the country will be expanded with the construction of this special high-mountain laboratory. On the basis of the cooperation between the Bulgarian and Hungarian academies of sciences, Hungarian scientists will also participate in these investigations.

The installation of equipment in the cosmic laboratory will begin very shortly. Scientific and research apparatus manufactured in Hungary will be installed. ("Completion of the First Cosmic Laboratory in Bulgaria"; Moscow, Sovetskaya Aviatsiya, 21 Oct 59, p 3)

III. METEOROLOGY

Another Soviet "First"

The first radiosonde was used by P. A. Molchanov, a Russian engineer, according to an article in Tekhnika Molodezhi. This method of studying the atmosphere, it goes on to say, is now used throughout the world.

The Kazan plant of technical rubber products is identified as one of the suppliers of the balloons used in great numbers by Soviet meteorological stations in their investigations with radiosondes and pilot balloons. ("Radiosondes"; Tekhnika Molodezhi, No 9, Sep 59, p 18)

IV. GRAVIMETRY

Review of Brochure Containing two Articles on Free-Air Anomalies

 The text of the review is as follows,

The investigations of the author in the first work represent a re-examination of the residual errors which occur in the use of the free-air reduction for the determination of the height of the geoid according to the Stokes formula. On the basis of the works of Jeffreys, the orders of magnitude of these residual errors are determined, whereby, in the end result, only the terms of those expansions are neglected whose influence on the height of the geoid is less than one centimeter.

The work is divided into seven sections, in which, one after the other, and with the use of the free-air reduction Δg_F, the formulas are derived for the perturbation potential T_σ at the surface of the earth, and a practical computation is made of this value, through analysis into $T_{\sigma 1}$ and $T_{\sigma 2}$, and of the required auxiliary functions Φ_1 to Φ_6. From these values, the author obtains sufficiently rigorous values of N_σ for the geoid undulations.

The particular value of these investigations lies in the consistent error estimation for all terms so that the stipulated one-centimeter limit is maintained. These investigations represent a critical disagreement with many earlier works in this special field. The work ends with a collection of formulas, with instructions for practical calculations of geoid altitudes. The extraordinarily thorough work is supplemented by a comprehensive bibliography of the most modern appropriate publications.

In the second work, the author derives, with the aid of spherical functions, the anomaly value of gravity for points in space surrounding the earth. Beginning with the value for the perturbation potential T, on the basis of the second identity of Green, he finds the very extensive formula expressing $(g - \gamma)$ of a space point in outer space.

An analogous expansion for the special case of a horizontal terrain leads to a simpler formula using the spherical-function expansion 1 Y_n for the free-air anomalies Δg_F up to the order n=10.

These theoretical observations can have a practical value for the investigations of the gravitational field of the earth which, in the future, will be conducted with the aid of artificial satellites at great altitudes above the surface of the earth. (Zur Bestimmung der Geoidundulationen aus Freiluftanomalien. Schwerewerte in grossen Hoehen ueber der Erdoberflaeche [On the Determination of Geoid Undulations From Free-air Anomalies. Gravity Values at Great Altitudes Above the Earth's Surface], by K. Arnold. Veroeffentlichung des Geodaetischen Instituts Potsdam Nr 12, Berlin 1959, 69 pp, 13 illustrations, reviewed by H. Peschel; Berlin, Vermessungstechnik, No 10, Oct 59, p 293)

V. OCEANOGRAPHY

Soviet Ships Visit Conakry, Republic of Guinea

Two Soviet scientific travlers, the Orekovo and the Oskol, are reported to have stopped recently at Conakry, Republic of Guinea, to take on new supplies. It is the first time that Soviet ships have stopped at Conakry. (Leopoldville, Le Courrier d'Afrique, 14 Sep 59)

The Soviet oceanographic ship Sedov has been calling at the port of Conakry, Republic of Guinea. Its expedition is part of the IGC program. (Leopoldville, Le Courrier d'Afrique, 5 Oct 59)

VI. ARCTIC AND ANTARCTIC

Severnyy Polyus-8 Supplied for Winter Season

A. D. Il'in, Polar Aviation pilot, completed the last supply flight in 1959 to the drift station Severnyy Polyus-8. The polar scientists at this station now have sufficient supplies of food, fuel, scientific equipment, and other materials, to last until next spring. ("Yesterday at SP-8"; Moscow, Vodnyy Transport, 20 Oct 59)

Oceanographic Expedition Returns

The oceanographic expedition of the Arctic and Antarctic Institute, which had been conducting research from the hydrographic ship Azimut, returned to Leningrad on 20 October.

According to expedition chief, V. A Vedernikov, Candidate of Geographical Sciences, the expedition took about 3 months. For the first time, complex oceanographic research was conducted during the summer season in the most difficult sector of the Northern Sea Route, i.e., Proliv Vil'kitskogo, connecting Kara Sea and Laptev Sea. In this area, difficult ice conditions usually obstruct the passage of ships.

Soviet-designed buoy stations, which automatically record the direction and speed of currents, operated in this area during the whole navigation period for the purpose of hydrological research. The data thus obtained will help in the preparation of navigational aids for polar navigators.

In addition to associates of the Arctic and Antarctic Institute, a group of associates of Leningrad University and of the Higher Maritime Engineering School imeni Admiral S. L. Makarov took part in the expedition. ("Azimut Returns to Leningrad"; Moscow, Vodnyy Transport, 22 Oct 59)

Antarctic Flight Completed

On 12 October, a plane piloted by B. Osipov, chief of aviation detachment, took off from Mirnyy for the coastal station Lazarev, a distance of 3,500 kilometers. An intermediate landing was made at the Australian station Mawson.

Since the weather in the region of Queen Maud Land had suddenly changed for the worse, the continuation of the flight was postponed, and the plane returned to Mirnyy. On 16 October, the plane again landed at Mawson. It took off from there on 19 October, at 0530 hours Moscow time, and headed west. On the same day, at 1310 hours, the plane landed at the Belgian station Roi Baudouin. Two hours later, after refueling, the plane headed for the station Lazarev and landed there safely at 1805 hours.

The flight to Lazarev was made by a group of members of the Fourth Continental Antarctic Expedition, headed by expedition chief A. G. Dralkin. ("Mirnyy-Lazarev Flight Completed"; Moscow, Vodnyy Transport, 20 Oct 59)

Antarctic Train Arrives at Komsomol'skaya

On 19 October, at 0200 hours Moscow time, the sled-tractor train from Mirnyy arrived at the station Komsomol'skaya, 3,420 meters above sea level. Over 100 tons of miscellaneous expeditionary equipment were delivered to this station. The train, consisting of five tractors and seven trailer sleds, traveled the 870-kilometer distance from Mirnyy to Komsomol'skaya in 21 days.

According to a radio report from Mirnyy, the station Komsomol'skaya was reactivated and put in operation 5 hours after the arrival of the train. ("Sled-Tractor Train at Komsomol'skaya"; Moscow, Vodnyy Transport, 20 Oct 59)

New Radiosondes Supplied for Antarctica

A new supply of radiosondes, manufactured by the Riga Plant of Hydrometeorological Instruments, will be available to the meteorologists of the Fifth Antarctic Expedition.

The plant is to deliver 1,000 radiosondes, type RZ-049; 400 of these will be specially adapted for observations in Antarctica. ("1,000 Radiosondes for Antarctica"; Riga, Sovetskaya Latviya, 3 Oct 59)

New Book on Antarctica

A. F. Treshnikov, chief of the Second Continental Antarctic Expedition during 1956-1957, who spent 14 months in Antarctica, describes the activities of that expedition in a book based on a diary of his observations and impressions.

The author himself took part in several difficult sled-tractor traverses and traveled over vast unexplored regions. He also flew over a large area of that sector of Antarctica where Soviet scientists were conducting studies under the IGY program. He gives a detailed description of the scientific work under the IGY program and shows the contribution made by Soviet scientists in the discovery of Antarctica. He compares the life of Soviet scientists stationed at Mirnyy with that of the US scientists at Little America and describes friendly meetings with Australian and Japanese scientists.

Treshnikov's book may be included in the ranks of classical books by such outstanding polar explorers as Nansen, Amundsen, and Scott. (Zakovannyy V Led [Bound In Ice], by A. F. Treshinkov, Moscow,1959)

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